US010693282B2

(12) United States Patent
Cox et al.

(10) Patent No.: US 10,693,282 B2
(45) Date of Patent: Jun. 23, 2020

(54) **ELECTRICAL POWER SUPPLY STRUCTURES**

(71) Applicant: **Superior Tray Systems Inc.**, Delta (CA)

(72) Inventors: **Martin Cox**, Surrey (CA); **Parry Singh Mudhar**, Vancouver (CA); **Tuan Anh Nguyen**, Vancouver (CA); **Vladislav Leder**, Richmond (CA)

(73) Assignee: **SUPERIOR TRAY SYSTEMS INC.**, Delta (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/720,700**

(22) Filed: **Dec. 19, 2019**

(65) **Prior Publication Data**

US 2020/0127445 A1 Apr. 23, 2020

Related U.S. Application Data

(63) Continuation of application No. 16/381,911, filed on Apr. 11, 2019, now Pat. No. 10,554,024, which is a (Continued)

(30) **Foreign Application Priority Data**

May 2, 2017 (CA) 2965823

(51) **Int. Cl.**

H02G 3/08	(2006.01)
H02G 3/22	(2006.01)
H02B 1/20	(2006.01)
H02B 1/46	(2006.01)
H01B 9/02	(2006.01)

(Continued)

(52) **U.S. Cl.**
CPC ***H02B 1/20*** (2013.01); ***E04B 5/48*** (2013.01); ***H01B 9/02*** (2013.01); ***H02B 1/46*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC . H02B 1/20; H02B 1/46; H02B 1/305; H02B 1/202; H02B 1/26; H01B 9/02;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,291,195 A 9/1981 Blomqvist et al.
4,376,230 A 3/1983 Bargsten
(Continued)

FOREIGN PATENT DOCUMENTS

WO 9953584 A1 10/1999
WO 2006076746 A1 7/2006
(Continued)

OTHER PUBLICATIONS

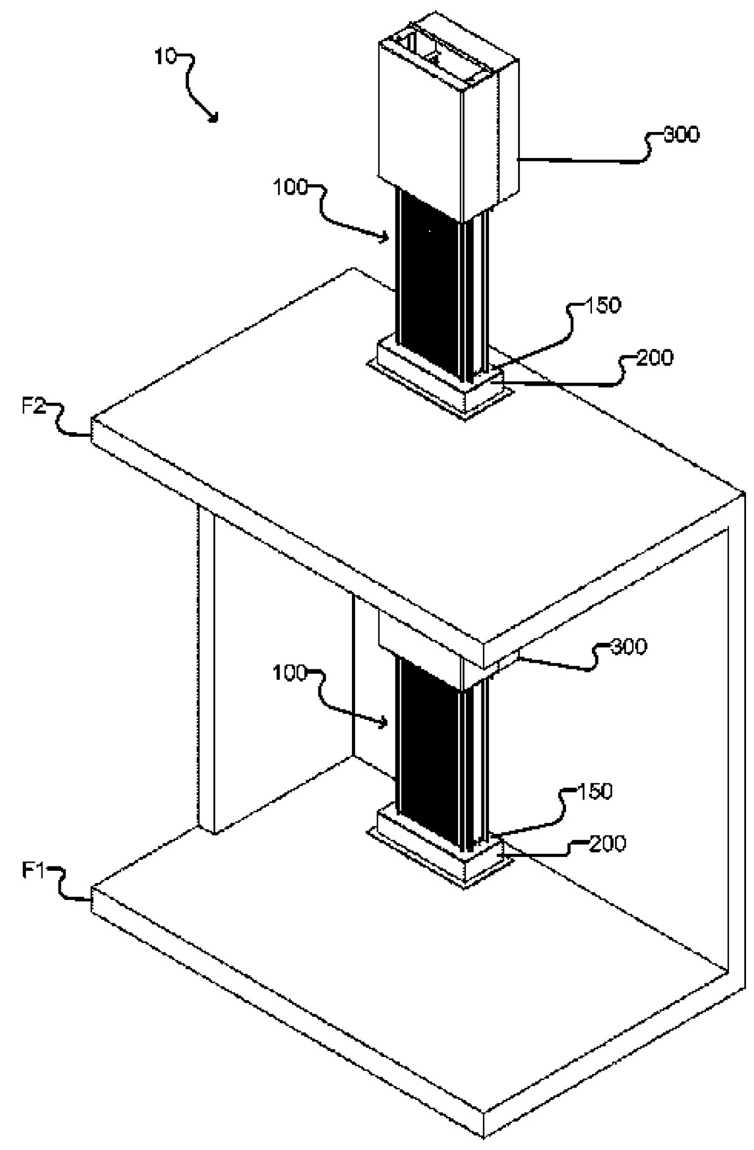
Office Action dated Jan. 2, 2019, issued by the USPTO on related U.S. Appl. No. 15/847,046.
(Continued)

Primary Examiner — Angel R Estrada
(74) *Attorney, Agent, or Firm* — Dentons Canada LLP

(57) **ABSTRACT**

The present disclosure provides an electrical power supply structure comprising a plurality of conductors, each conductor extending longitudinally and configured to carry high amperage electrical power, a barrier support plate comprising one or more openings for receiving the plurality of conductors, a first support structure extending longitudinally from a first side of the barrier support plate, and a second support structure extending longitudinally from a second side of the barrier support plate. Each of the first and second support structures comprises a longitudinally extending enclosure having a plurality of transversely extending conductor support members for supporting the plurality of conductors.

6 Claims, 9 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/847,046, filed on Dec. 19, 2017, now Pat. No. 10,305,263.

(51) **Int. Cl.**

E04B 5/48	(2006.01)
H02G 3/34	(2006.01)
H02G 3/04	(2006.01)
H02B 1/30	(2006.01)
H02G 5/08	(2006.01)
H02G 5/06	(2006.01)
H02G 3/32	(2006.01)

(52) **U.S. Cl.**

CPC ***H02G 3/0431*** (2013.01); ***H02G 3/22*** (2013.01); ***H02G 3/34*** (2013.01); *H02B 1/305* (2013.01); *H02G 3/0412* (2013.01); *H02G 3/0456* (2013.01); *H02G 3/32* (2013.01); *H02G 5/06* (2013.01); *H02G 5/08* (2013.01)

(58) **Field of Classification Search**

CPC H01B 9/00; H02G 3/0431; H02G 3/22; H02G 3/34; H02G 3/0412; H02G 3/0456; H02G 3/32; H02G 5/06; H02G 3/08; H02G 3/081; H02G 5/08; E04B 5/48

USPC .... 174/50, 68.1, 68.3, 72 A, 135, 149 R, 174/149 B; 248/56, 68.1, 74.1, 74.2; 385/134, 135; 52/220.1, 220.3, 220.7, 52/220.8; 312/223.1, 223.2, 223.6; 361/624

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,702,444	A	10/1987	Beele	
4,767,086	A	8/1988	Blomqvist	
5,391,840	A	2/1995	Hughes et al.	
5,665,939	A	9/1997	Jorgensen et al.	
5,992,802	A	11/1999	Campbell	
6,590,154	B1	7/2003	Badey et al.	
6,706,969	B1	3/2004	Young	
7,477,500	B2	1/2009	Schmidt et al.	
RE42,266	E	4/2011	Sparrowhawk	
8,193,448	B2	6/2012	Syed	
8,294,030	B2	10/2012	Pollard, Jr.	
9,059,575	B2	6/2015	Pawluk	
10,305,263	B2 *	5/2019	Cox	E04B 5/48
2015/0255967	A1	9/2015	Pawluk	
2016/0050782	A1	2/2016	Englert et al.	

FOREIGN PATENT DOCUMENTS

WO	2006097600	A1	9/2006
WO	2007006961	A1	1/2007
WO	2011146567	A2	11/2011
WO	2013142874	A1	9/2013

OTHER PUBLICATIONS

Office Action dated May 14, 2019, issued by the USPTO on related U.S. Appl. No. 16/381,911.

* cited by examiner

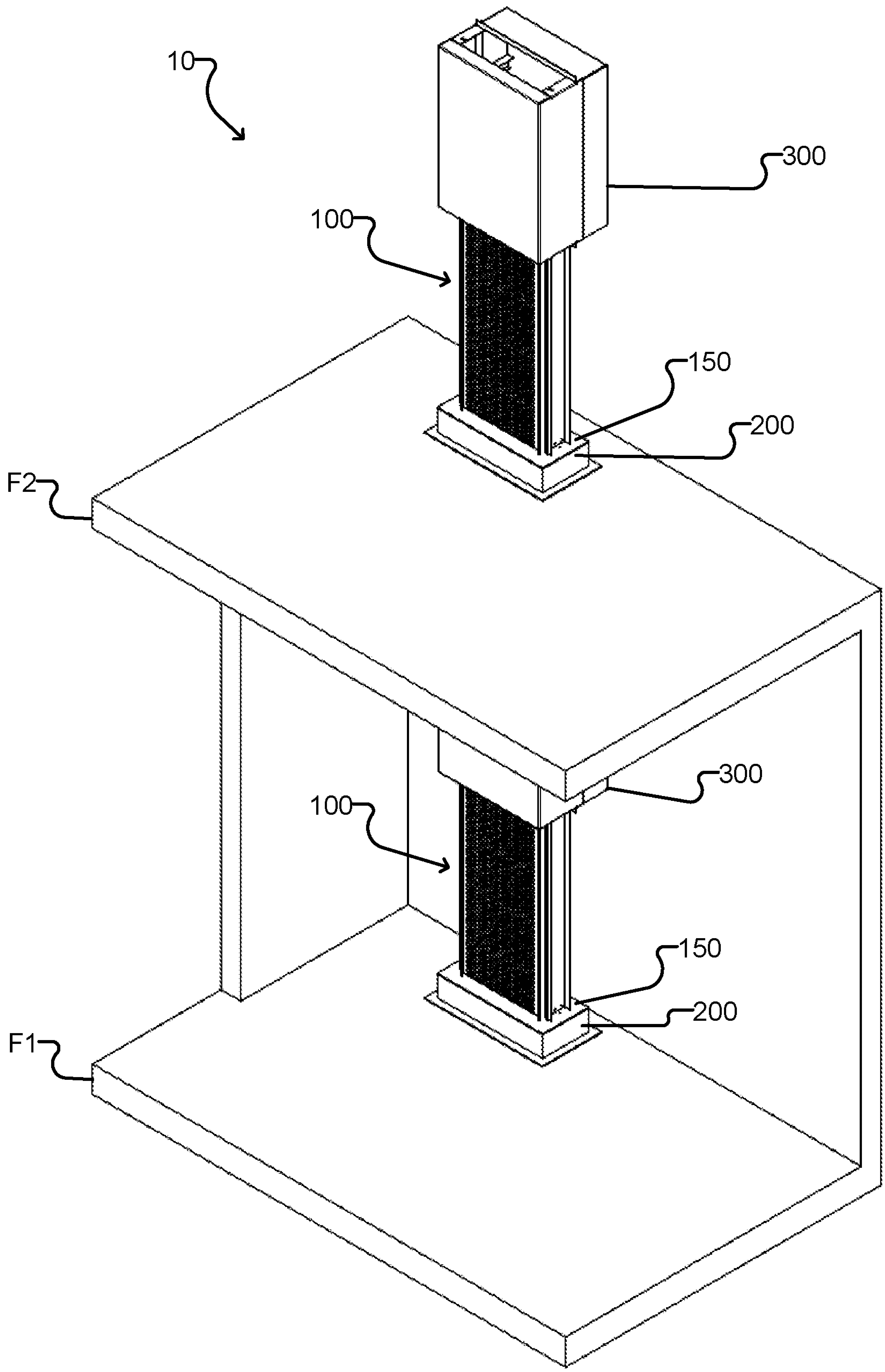


FIG. 1

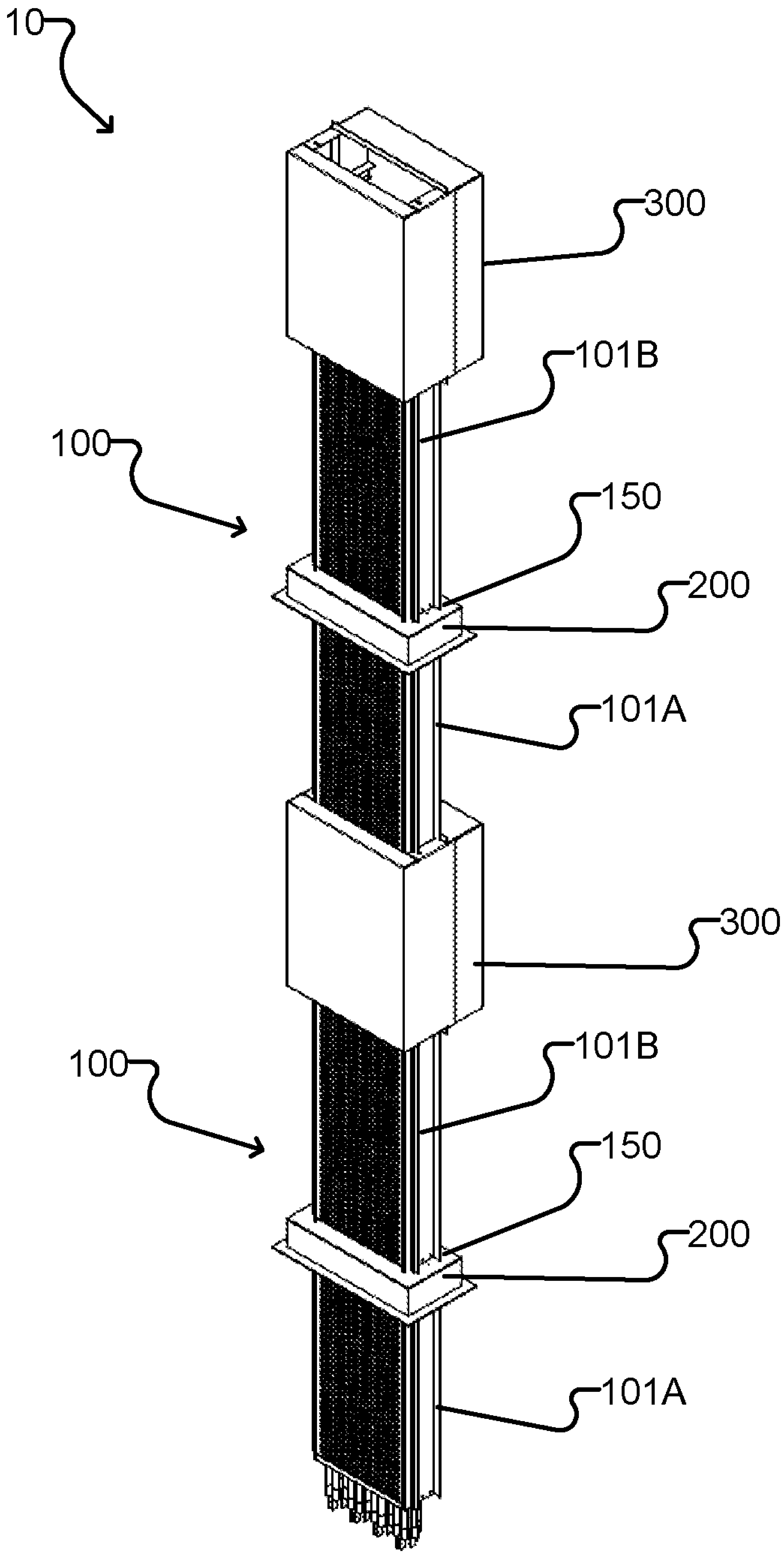

10
300
101B
100
150
200
101A
300
101B
100
150
200
101A

FIG. 2

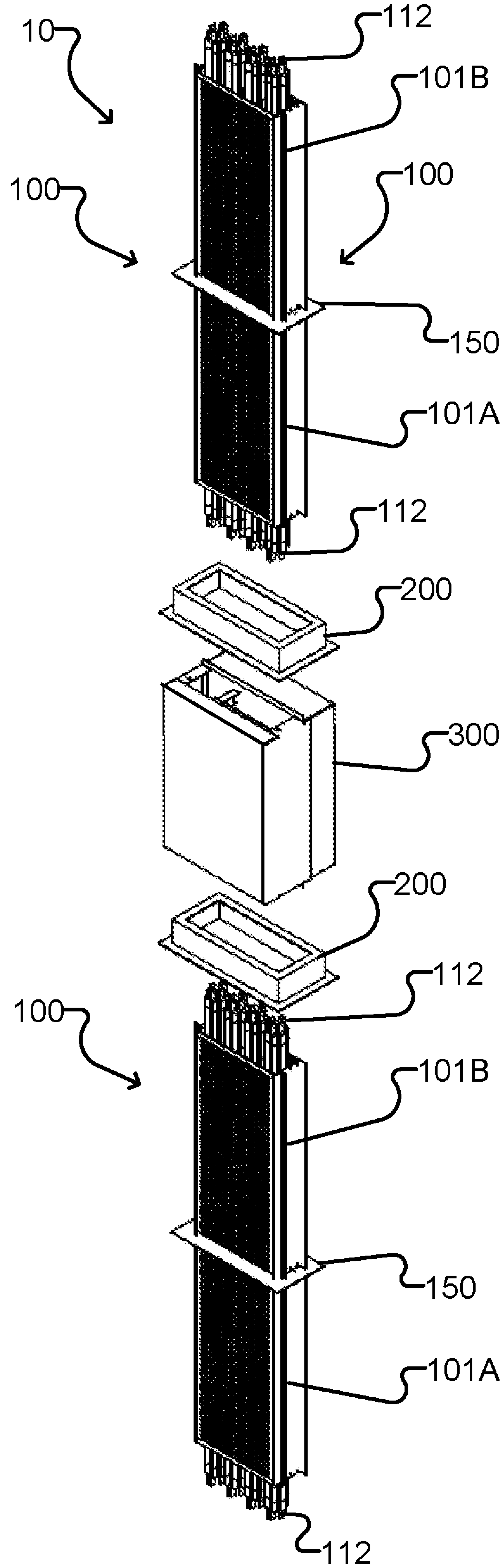

10
112
101B
100
100
150
101A
112
200
300
200
112
100
101B
150
101A
112

FIG. 2A

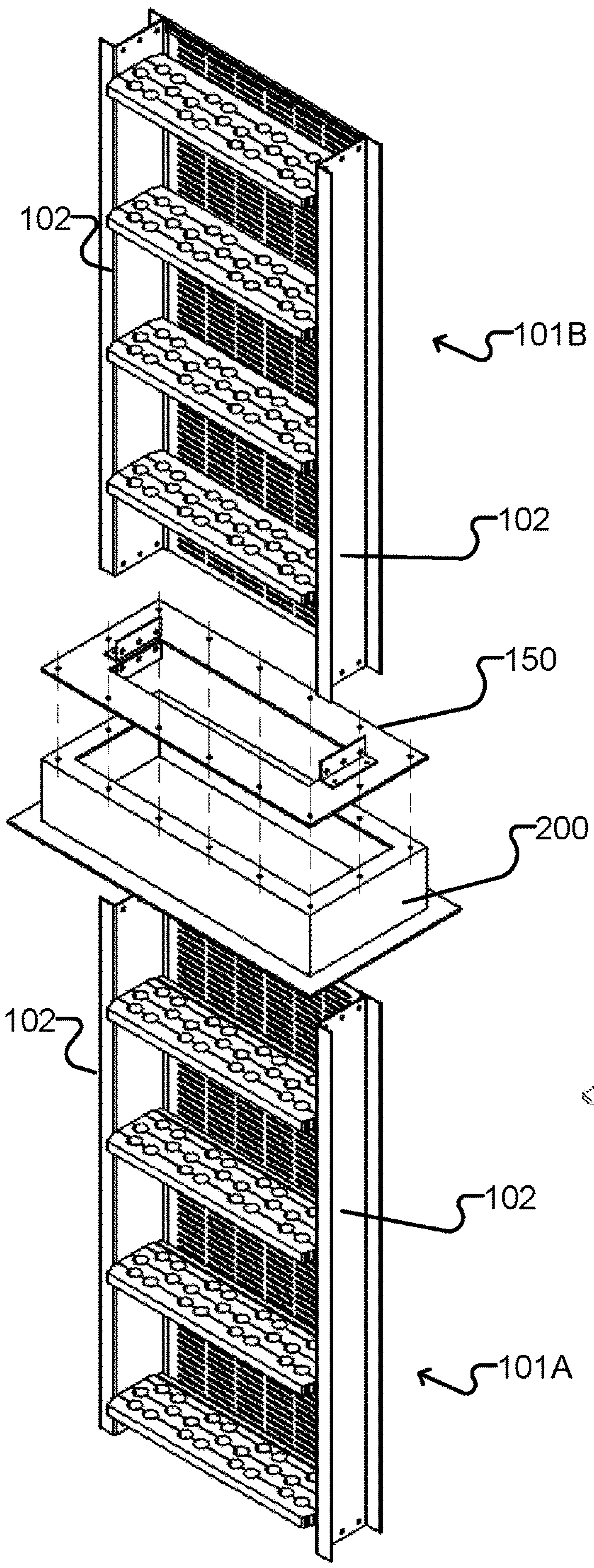


FIG. 2B

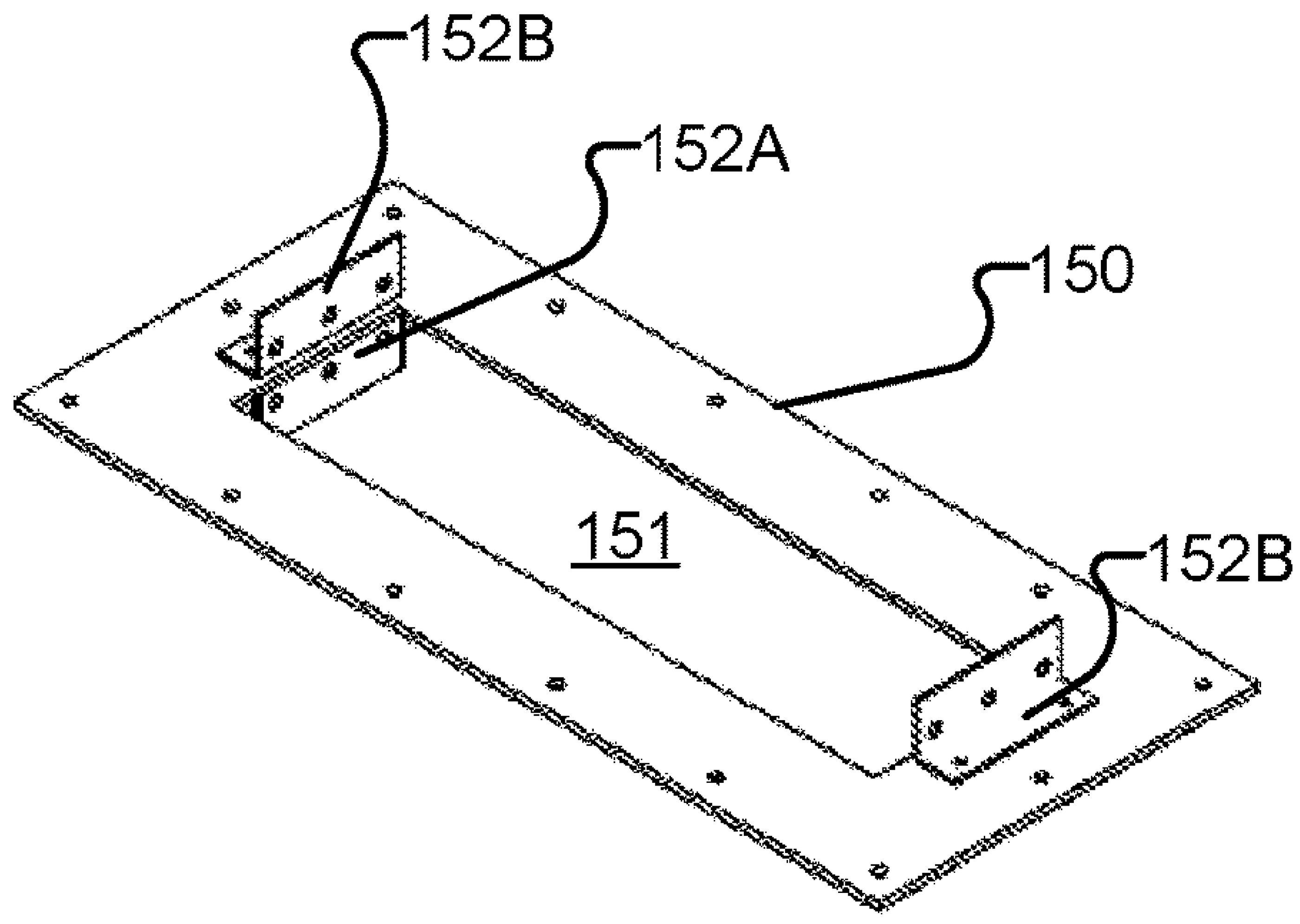


FIG. 2C

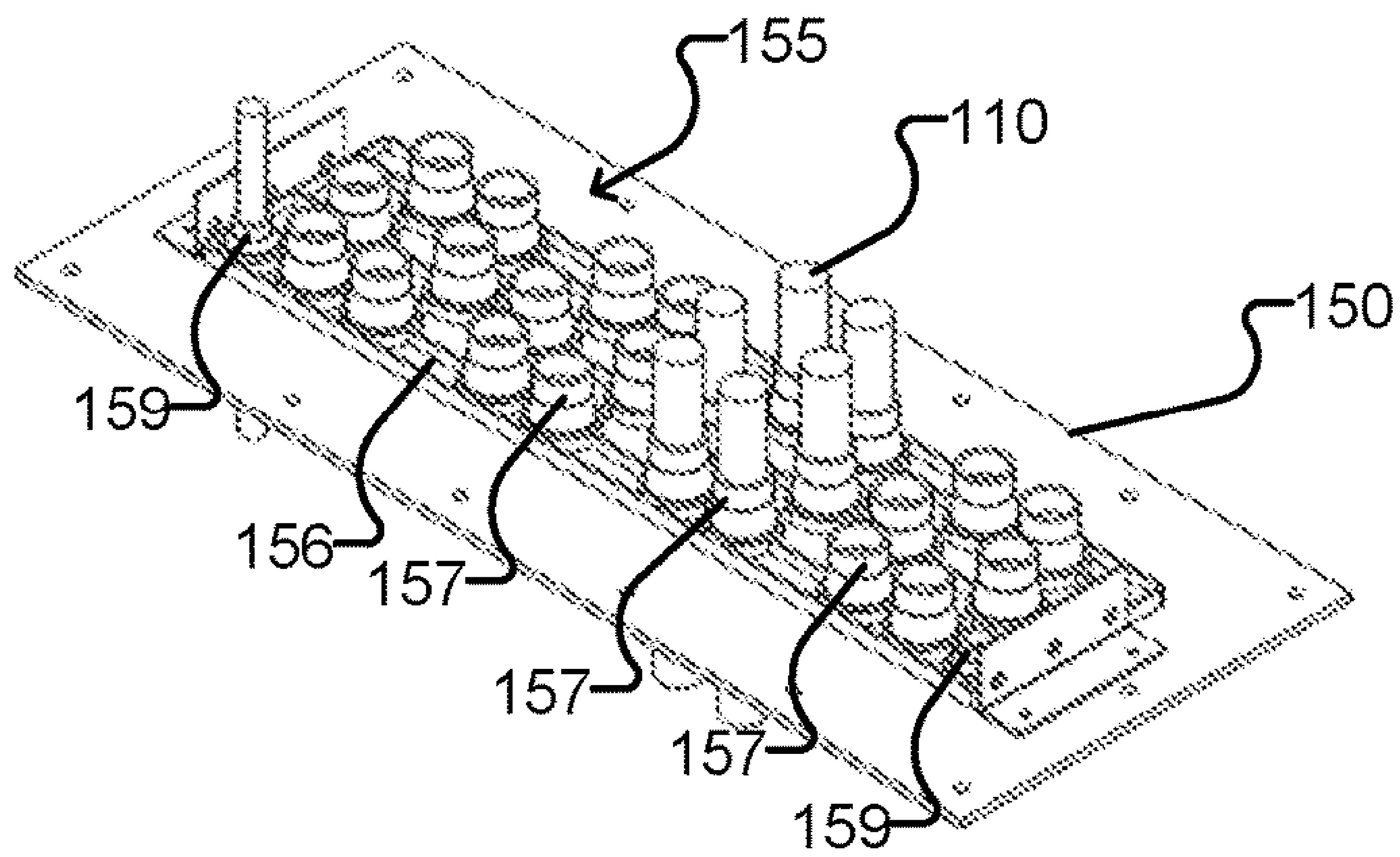


FIG. 2D

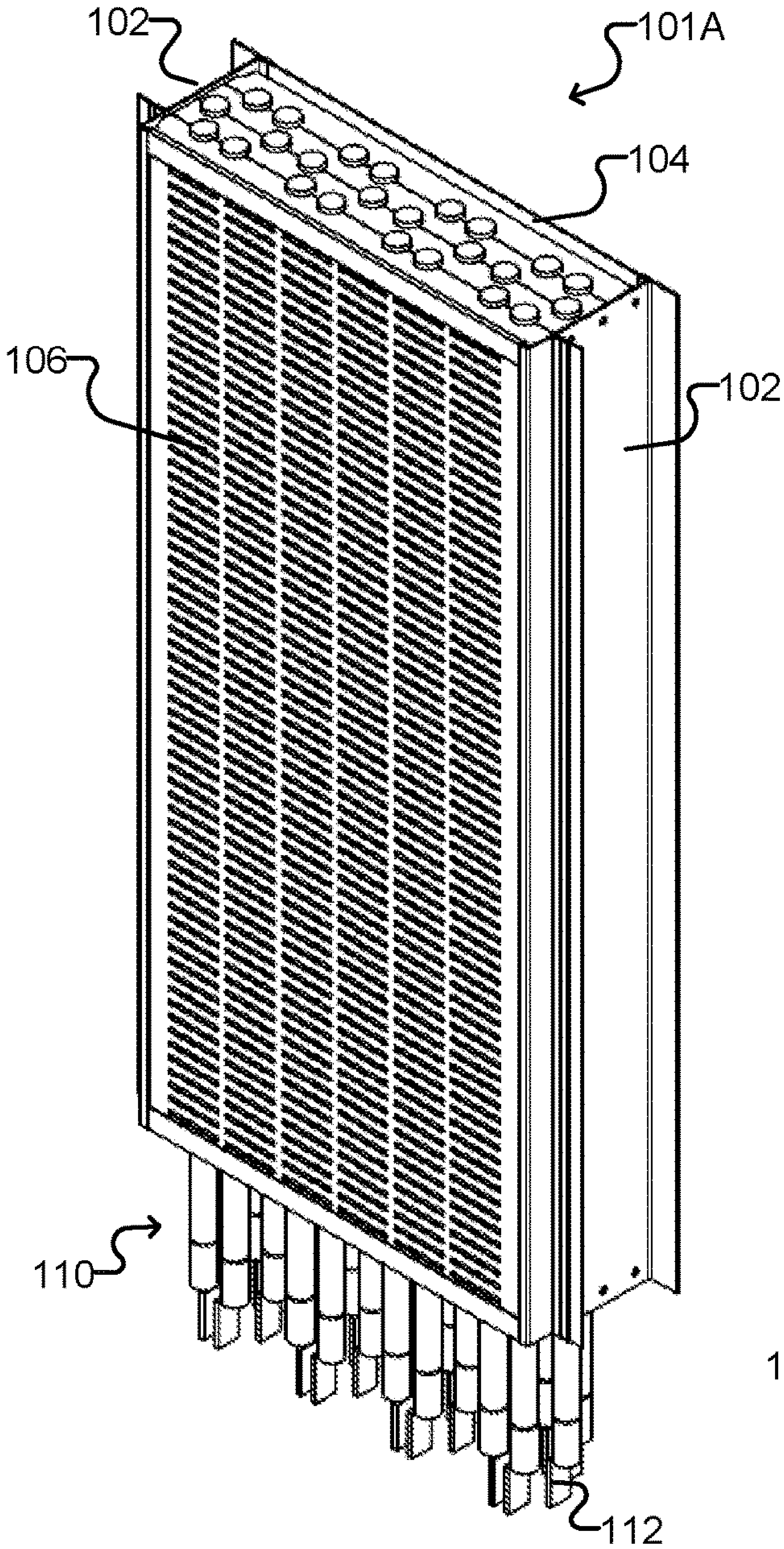


FIG. 3

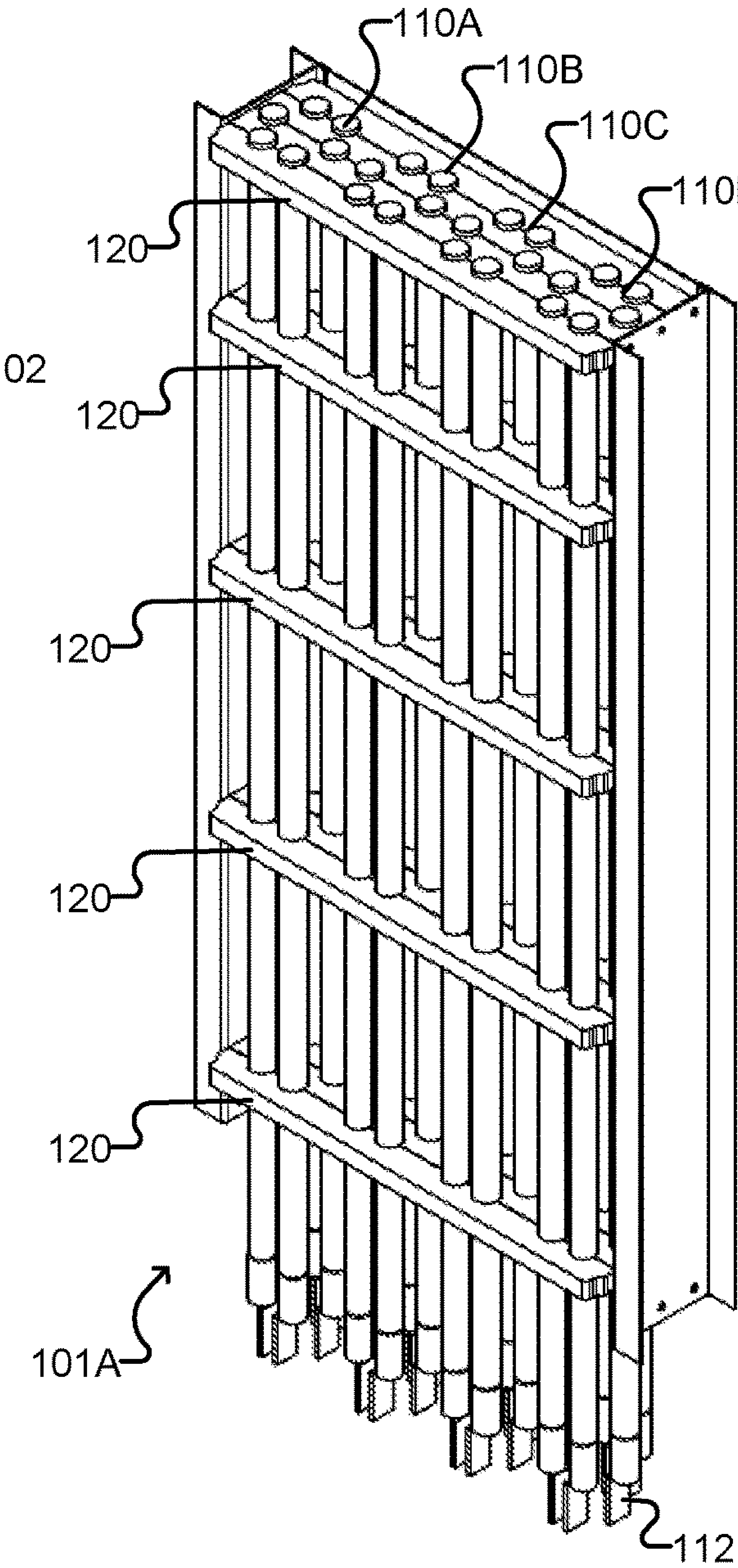


FIG. 3A

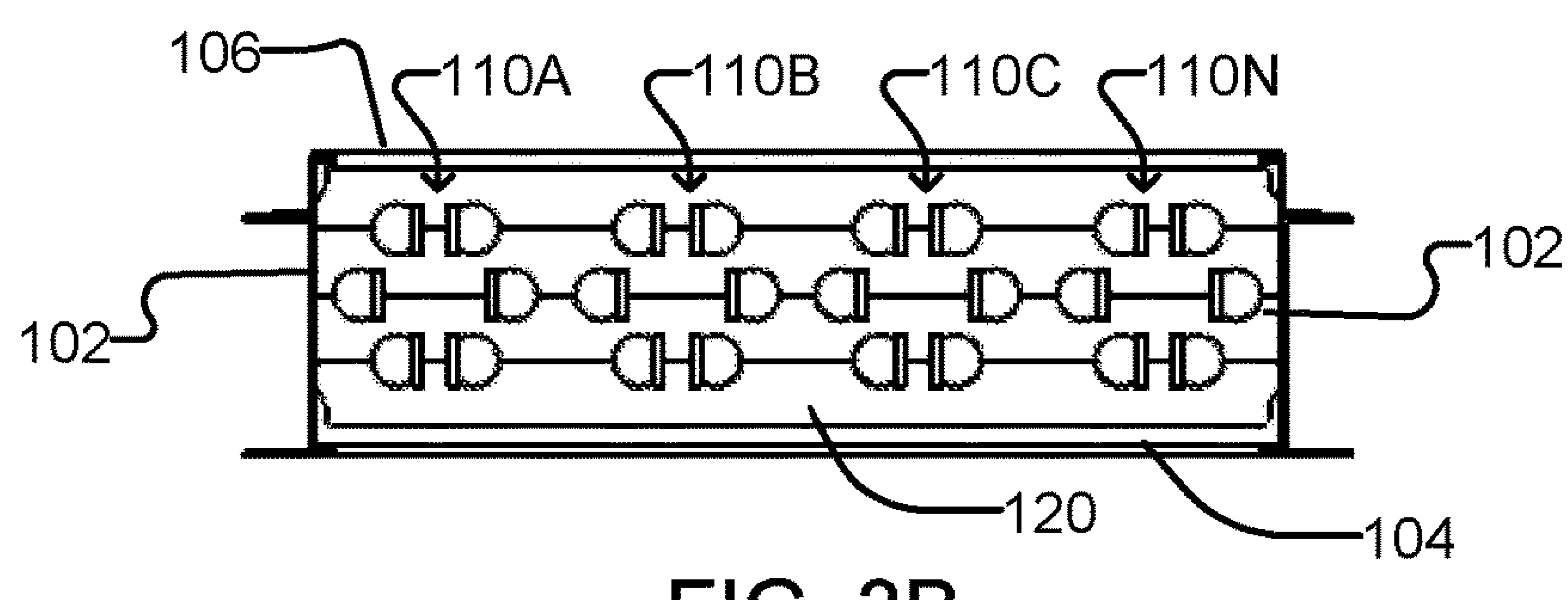


FIG. 3B

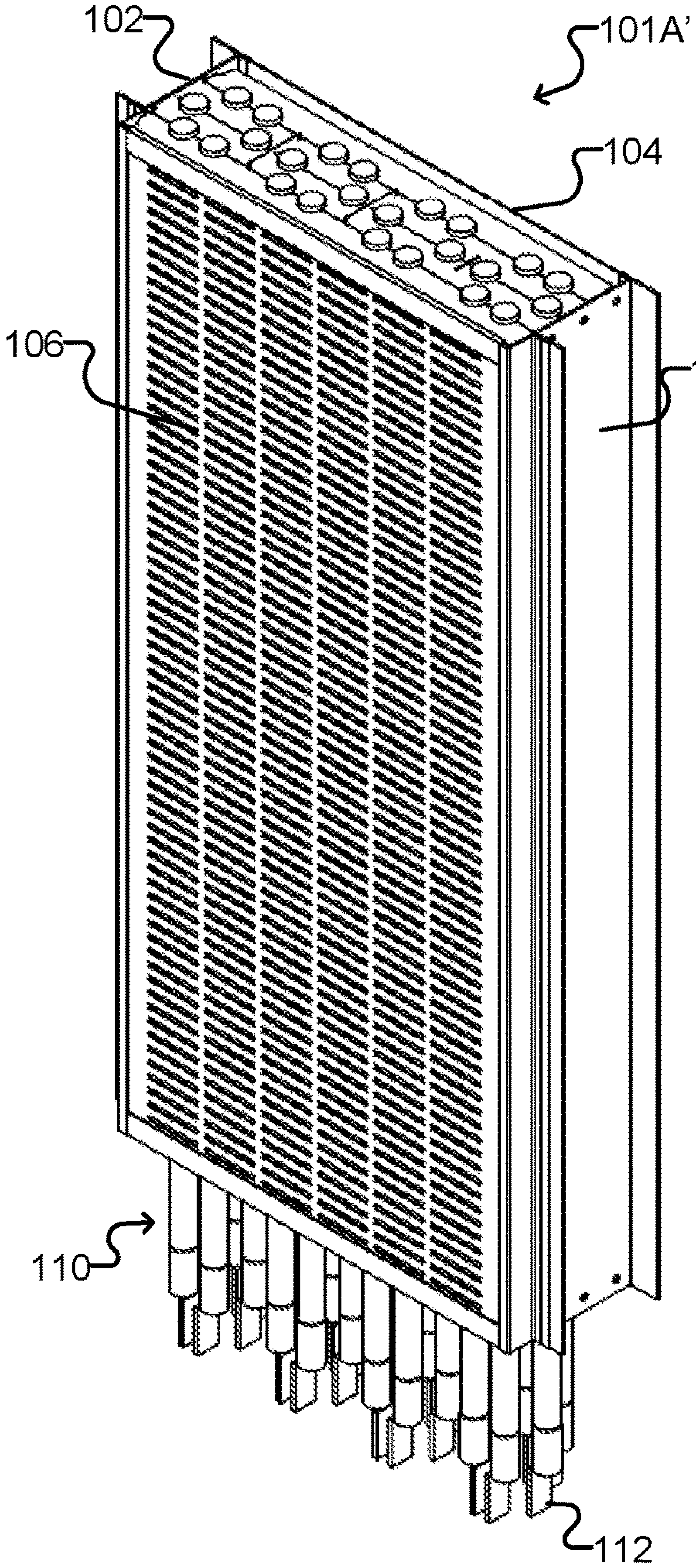


FIG. 4

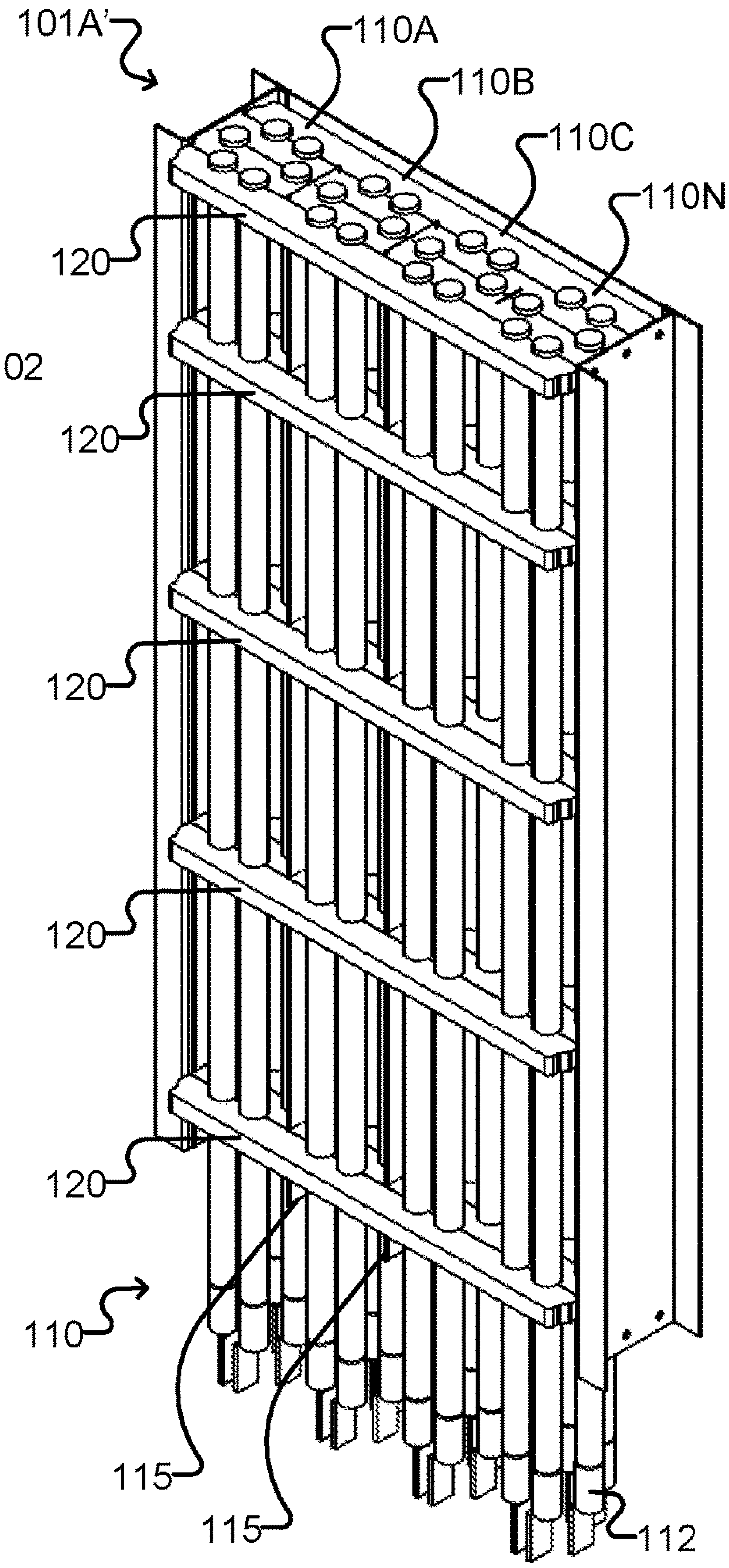


FIG. 4A

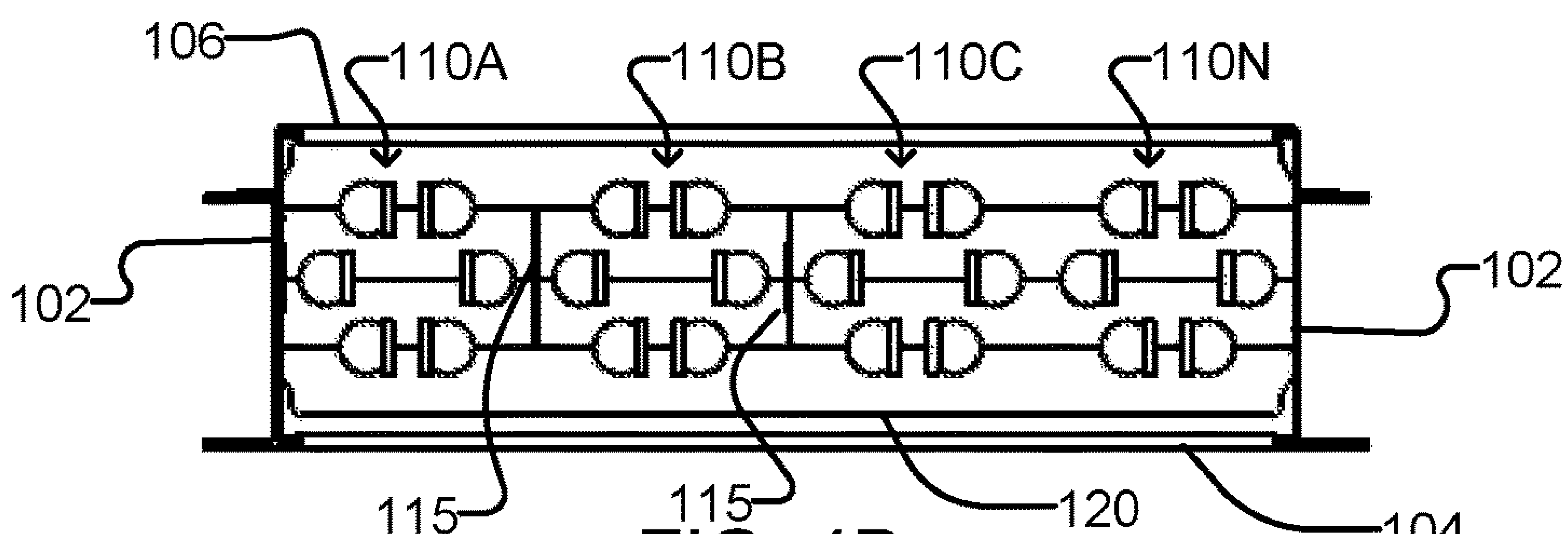


FIG. 4B

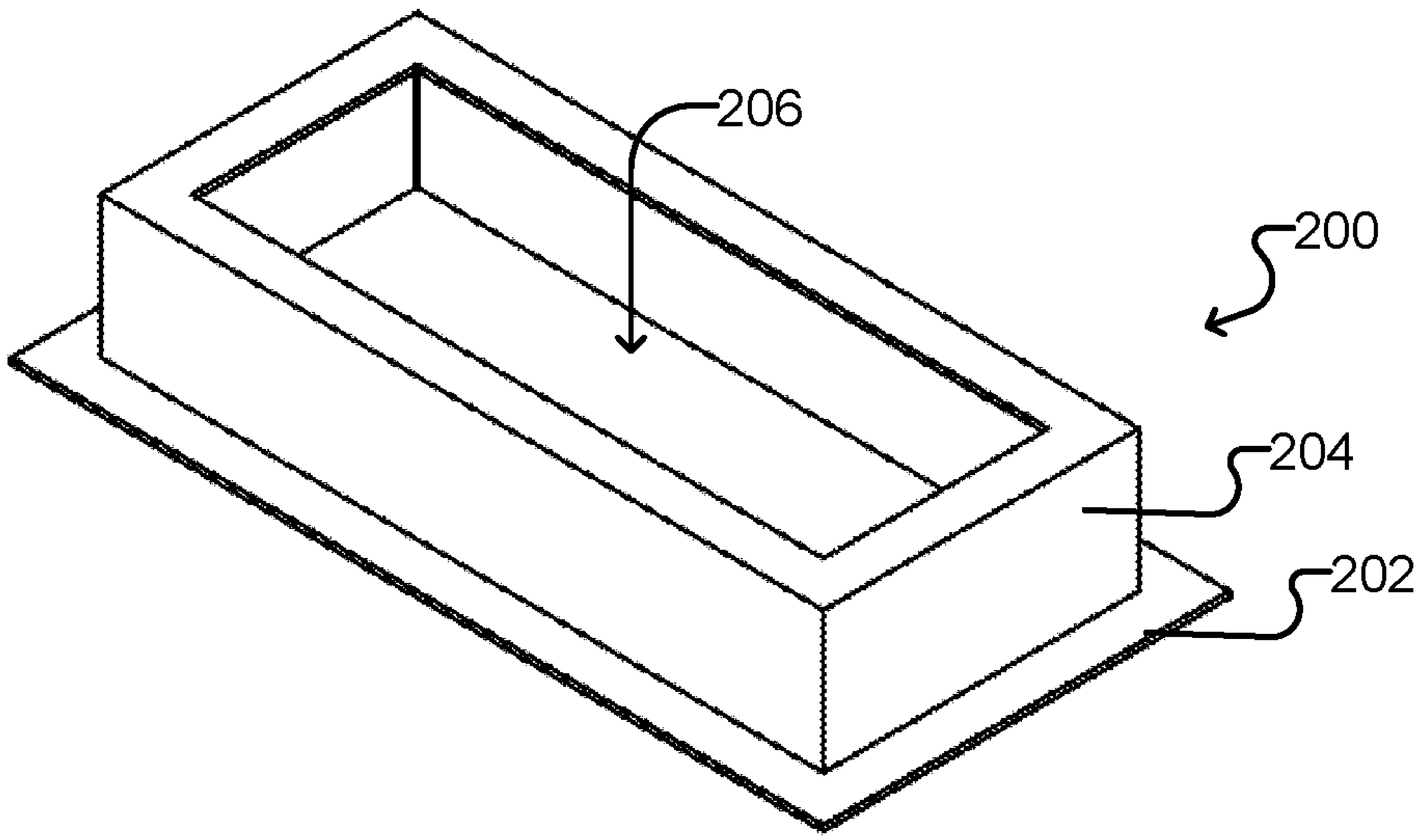


FIG. 5

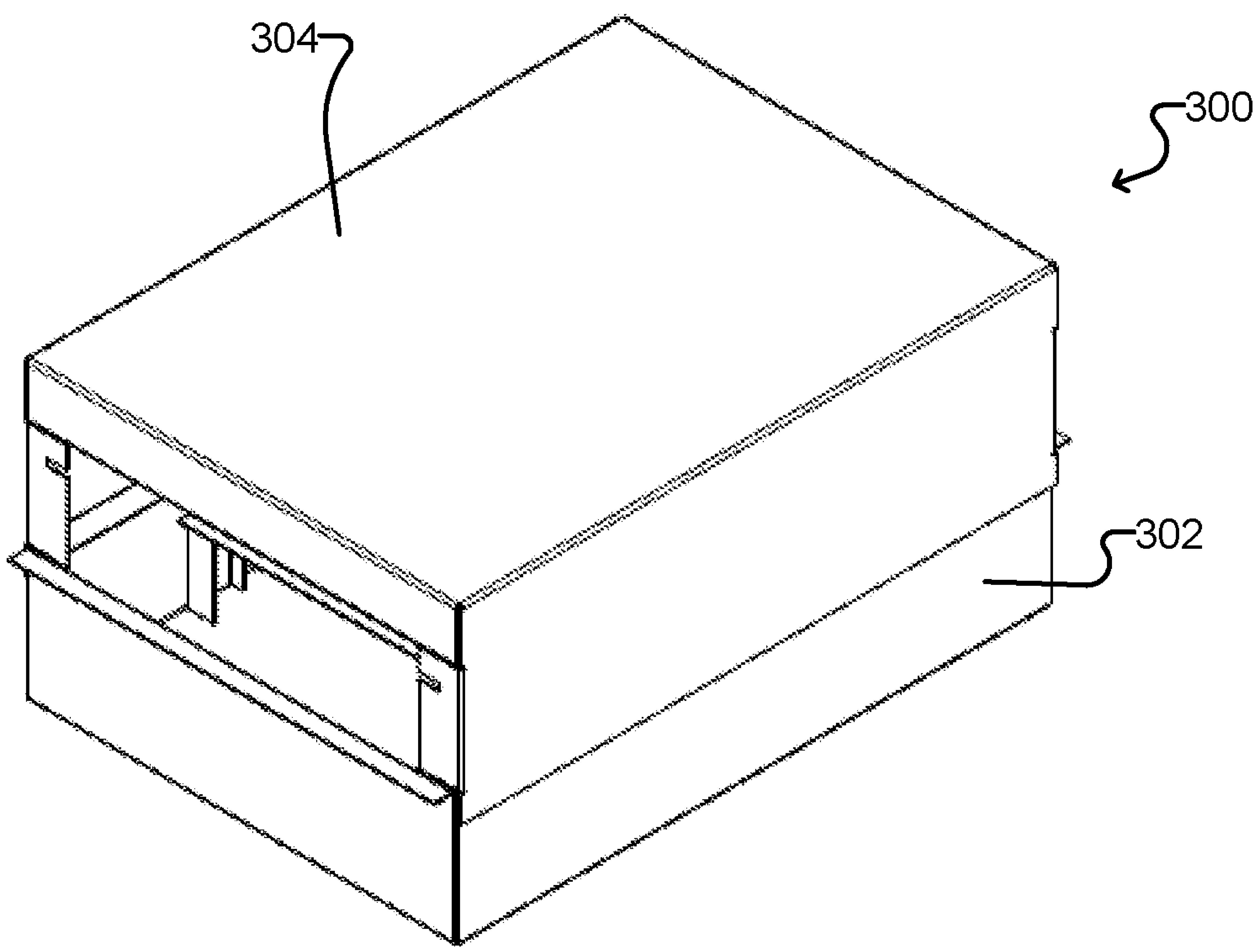


FIG. 6

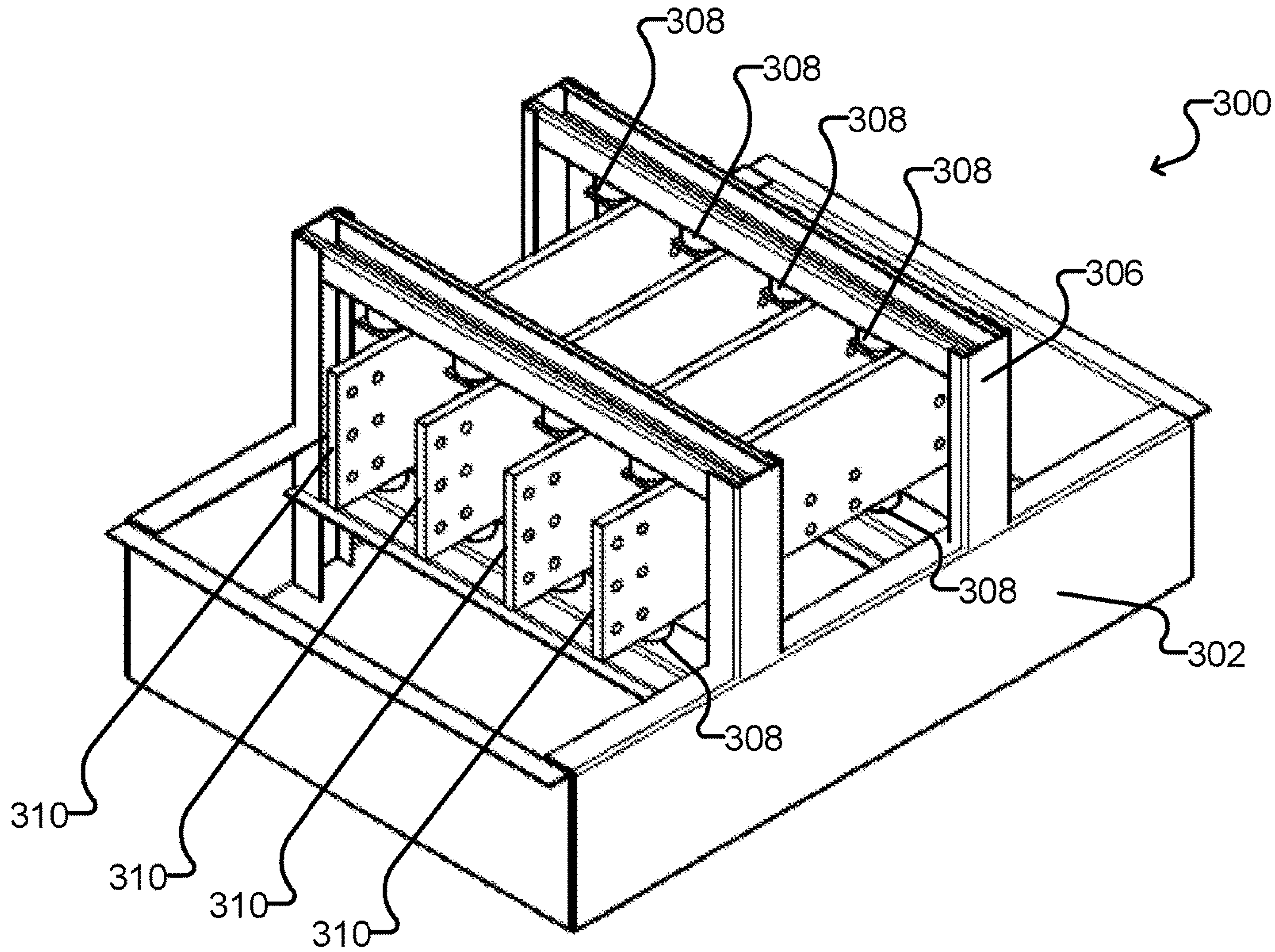


FIG. 6A

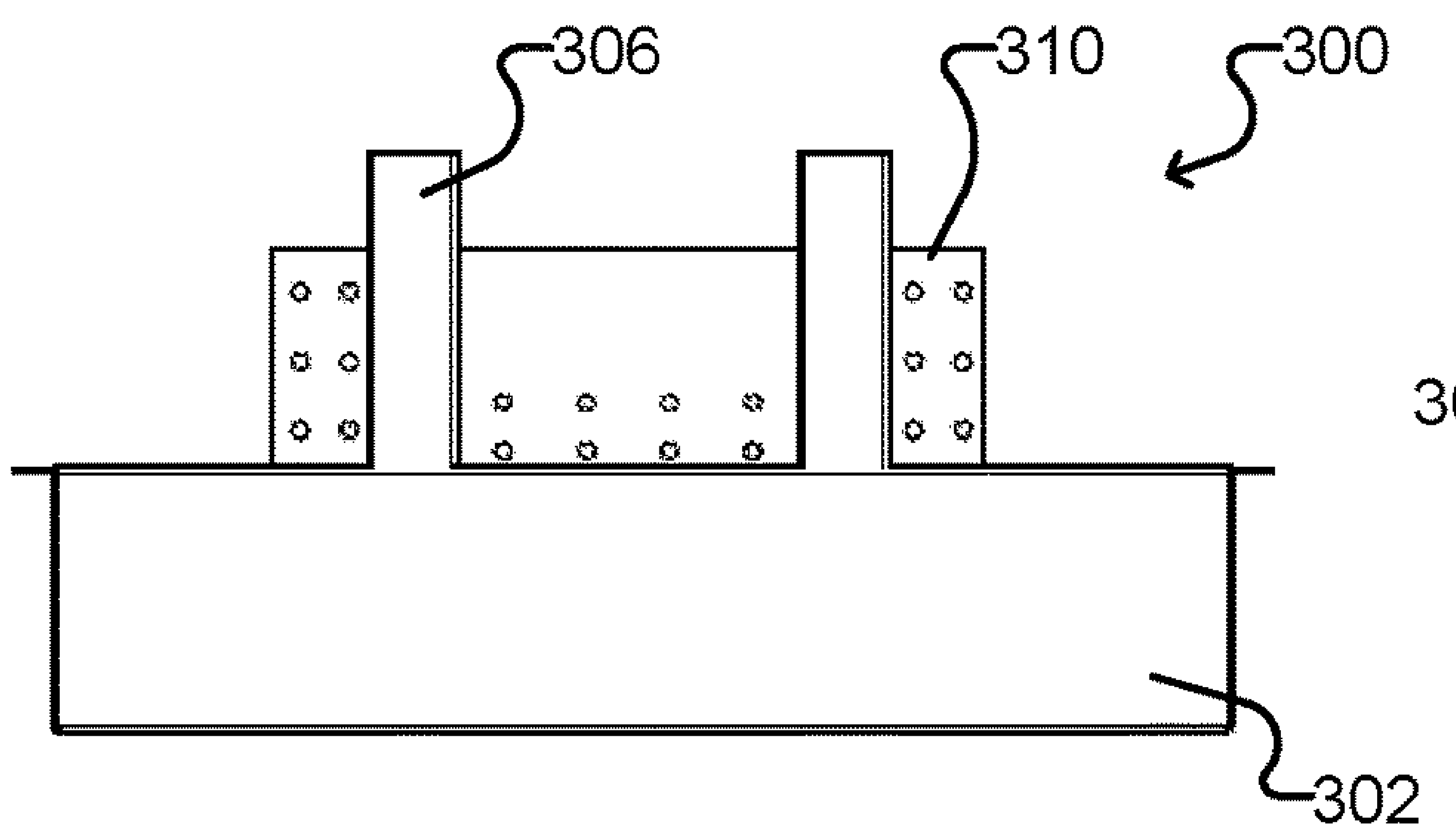


FIG. 6B

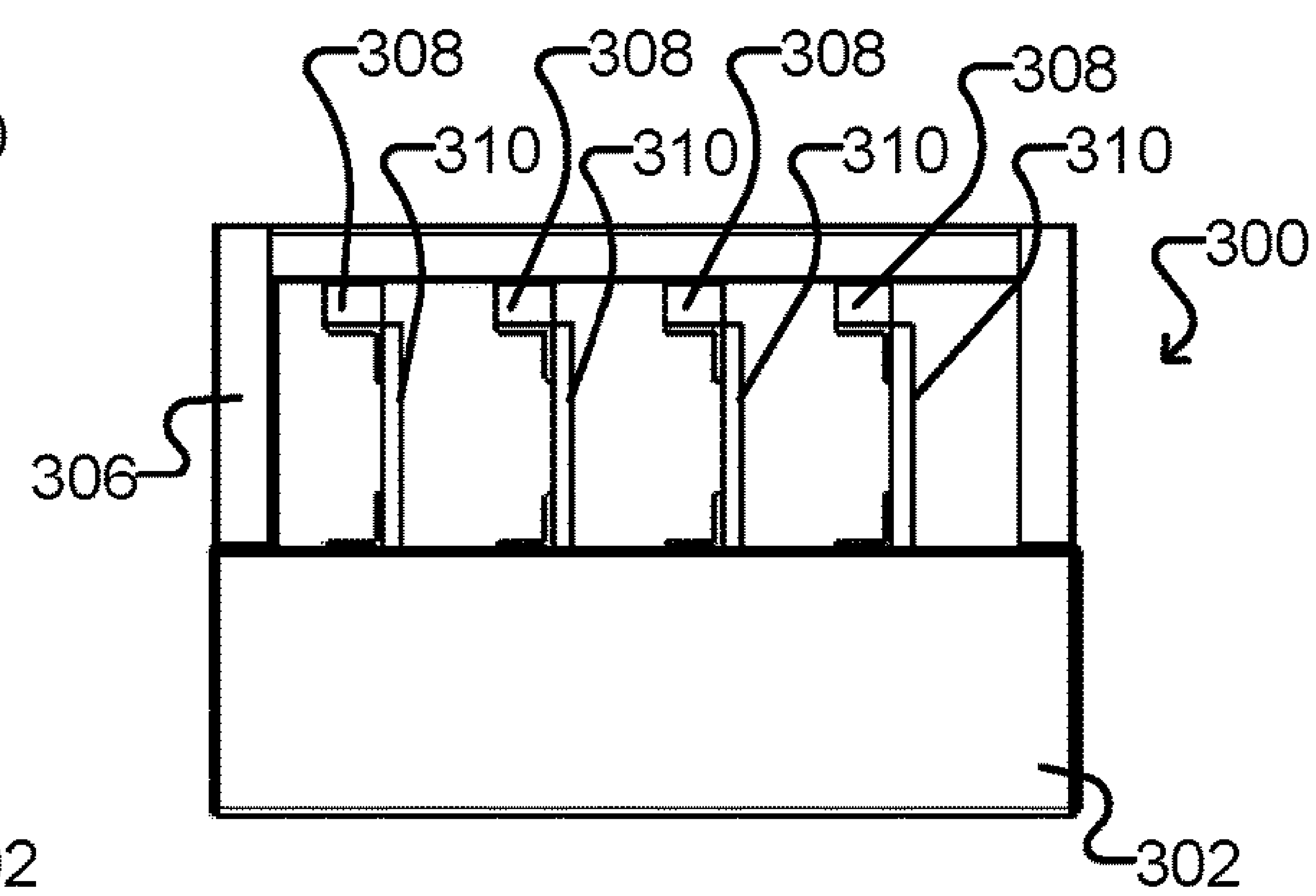


FIG. 6C

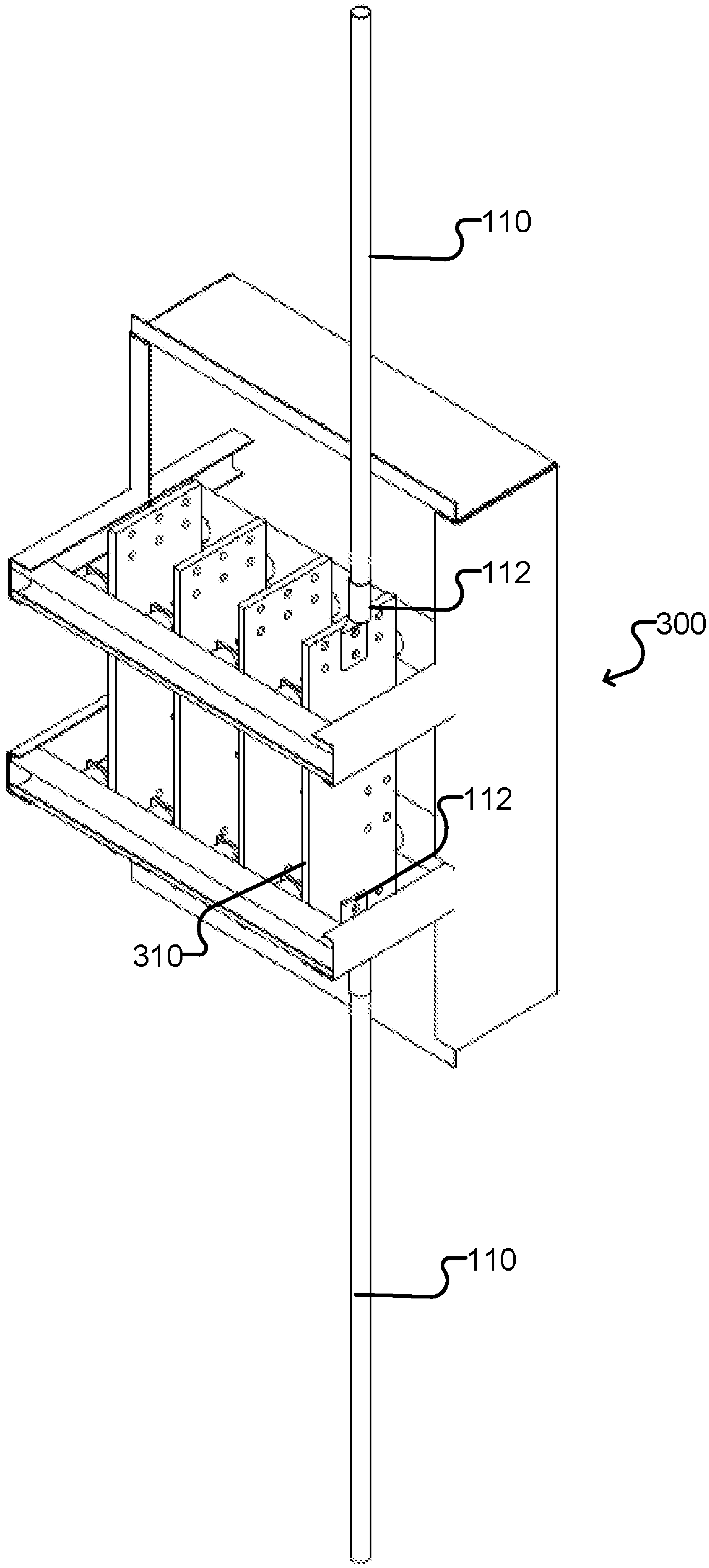


FIG. 6D

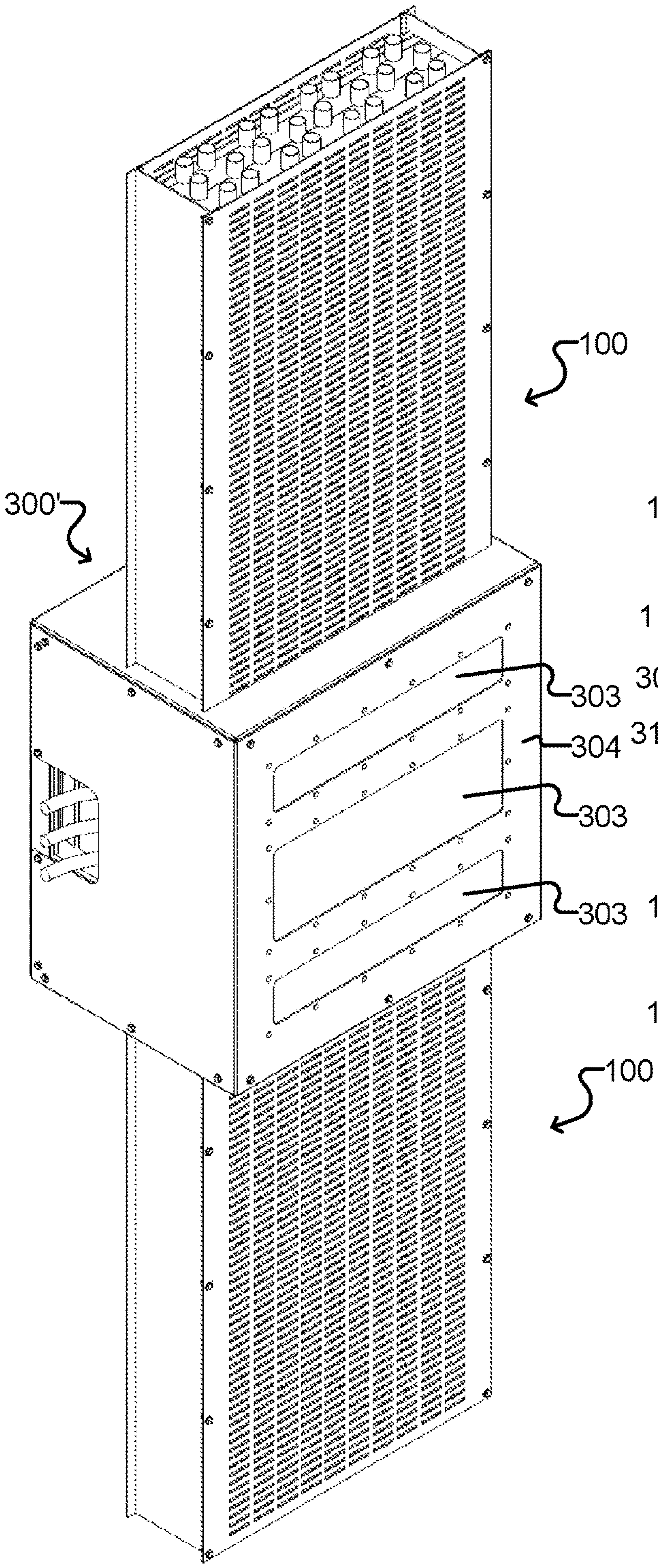

100
300'
303
304
303
303
100

FIG. 7

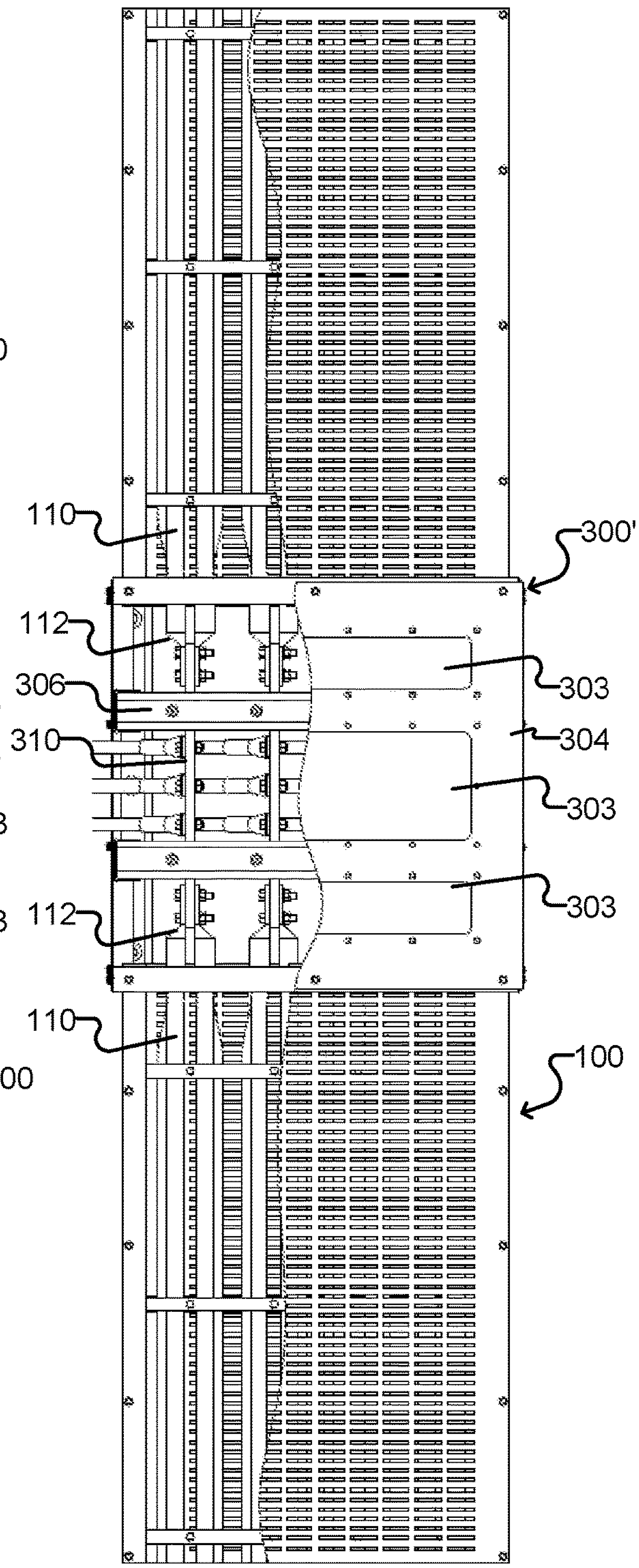

110
300'
112
303
306
304
310
303
112
303
110
100

FIG. 7A

ELECTRICAL POWER SUPPLY STRUCTURES

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 16/381,911 filed on Apr. 11, 2019, which is a continuation of U.S. patent application Ser. No. 15/847,046 filed on Dec. 19, 2017, which in turn claims the benefit of priority of Canadian Patent Application No. 2,965,823 filed on May 2, 2017. U.S. patent application Ser. No. 16/381,911, U.S. patent application Ser. No. 15/847,046 and Canadian Patent Application No. 2,965,823 are hereby incorporated herein by reference in their entirety.

TECHNICAL FIELD

The present disclosure relates to distribution of electrical power within multi-story buildings.

BACKGROUND

In multi-story structures such as office towers, condominiums, apartments, and other buildings, electrical power is typically distributed with the use of bus ducts which run vertically through multiple floors of the building. At various points along a vertical bus duct, connection points such as bus plugs are needed to tie in cables that distribute power throughout each floor. Depending on power requirements, construction details, and other factors at play in a building a bus duct may have connection points on every floor, every other floor, or any other desired pattern.

Existing bus ducts are typically expensive and time consuming to install and replace. A typical bus duct has a number of rigid conductors, and these conductors must be securely connected at a joint between adjacent bus duct sections, often with a blade-type connection with bolts used to squeeze the conductors together. Such joints can present relatively high resistance, and some jurisdictions require that the bolts in the joints of a bus duct be re-torqued every six months. Further, due to seismic considerations, rigid bus ducts must typically be installed with their longer lateral sides oriented perpendicularly to a structural wall, such that the area footprint required for the bus duct can be significantly larger than the cross-sectional area of the bus duct itself.

The inventors have determined a need for improved structures and systems for distribution of electrical power in multi-story buildings.

SUMMARY

One aspect provides an electrical power supply structure comprising a barrier support plate comprising one or more openings configured for mounting over a hole through a floor of a building, a first support structure extending longitudinally upward from an upper side of the barrier support plate, and, a second support structure extending longitudinally downward from a lower side of the barrier support plate through the hole. Each of the first and second support structures comprises a longitudinally extending enclosure having a plurality of transversely extending conductor support members. The structure is configured to receive a plurality of conductors extending longitudinally therethough, with the conductors extending through the one or more openings in the barrier support plate and being supported by the plurality of transversely extending conductor support members of the first and second support structures.

The electrical power supply structure may comprise a spacer block having an opening sized to fit an outer dimension of one of the first and second support structures and configured to be mounted between the barrier support plate and a floor of a building such that the barrier support plate is held at a predetermined height above the floor.

The conductors may be insulated. The conductors may be grouped by phase. The insulated conductors in each group may be arranged in a circular arrangement. The electrical power supply structure may comprise a shield plate between groups of insulated conductors of different phases.

Another aspect provides an electrical power distribution system for a high-rise building with a plurality of floors. The system comprises a plurality of electrical power supply structures of the present disclosure arranged in a vertical stack; a plurality of tap boxes for connecting the plurality of electrical supply structures, each tap box connected between two adjacent electrical power supply structures and comprising a tap bar for each phase of electrical power, the tap bar having a first end for connecting to all of the plurality of insulated conductors carrying that phase of electrical power in an upper one of the two adjacent electrical power supply structures, and a second end for connecting to all of the plurality of insulated conductors carrying that phase of electrical power in a lower one of the two adjacent electrical power supply structures. A length of each of the first and second support structures of each of the electrical power supply structures is selected such that each of the tap boxes is positioned at a predetermined height above one of the plurality of floors of the high-rise building.

Another aspect provides a cable bus for holding a plurality of high amperage electrical cables. The cable bus comprises a supporting structure extending in a longitudinal direction and defining a cable enclosure; and one or more shielding members extending within the supporting structure in the longitudinal direction and dividing the cable enclosure into two or more longitudinal chambers, and a plurality of cable support members extending in a transverse direction across the supporting structure. The plurality of cable support members are longitudinally spaced apart along a length of the supporting structure, and each cable support member comprises a plurality of cable holders arranged in a plurality of groups, each group located within one of the longitudinal chambers, such that the cable support members support electrical cables carrying multiphase electrical power and comprising a plurality of cables for each phase of electrical power, whereby each plurality of cables for each phase of electrical power are supported within a distinct longitudinal chamber.

Further aspects and details of example embodiments are set forth below.

DRAWINGS

The following figures set forth embodiments in which like reference numerals denote like parts. Embodiments are illustrated by way of example and not by way of limitation in the accompanying figures.

FIG. **1** shows a portion of an example electrical power supply structure installed between two floors of a building according to one embodiment of the present disclosure.

FIG. **2** shows the structure of FIG. **1** in isolation.

FIG. **2**A is an exploded view of the structure of FIG. **1**.

FIG. **2**B shows an exploded view of one of the bus sections of the structure of FIG. **1**.

FIG. 2C shows an example barrier support plate of a bus section.

FIG. 2D shows an example sealing system for a barrier support plate.

FIG. 3 shows a lower half of an example vertical bus section for the structure of FIG. 1.

FIG. 3A shows the structure of FIG. 3 with the cover removed.

FIG. 3B shows a bottom view of the structure of FIG. 3.

FIG. 4 shows a lower half of another example vertical bus section for the structure of FIG. 1.

FIG. 4A shows the structure of FIG. 4 with the cover removed.

FIG. 4B shows a bottom view of the structure of FIG. 4.

FIG. 5 shows an example spacer block for the structure of FIG. 1.

FIG. 6 shows an example tap box for the structure of FIG. 1.

FIG. 6A shows the tap box of FIG. 6 with the cover removed.

FIG. 6B is a side view of the tap box of FIG. 6A.

FIG. 6C is a bottom view of the tap box of FIG. 6A.

FIG. 6D shows a single conductor connected to a bus bar of a tap box.

FIG. 7 shows a tap box according to another embodiment of the present disclosure connected between two bus sections.

FIG. 7A shows the tap box and bus sections of FIG. 7 with portions of their covers cut away.

DETAILED DESCRIPTION

The following describes structures for supplying electrical power among multiple floors of a building. Example embodiments described below provide structures comprising vertical conductor sections and tap boxes that may be rapidly and securely connected to facilitate installation.

For simplicity and clarity of illustration, reference numerals may be repeated among the figures to indicate corresponding or analogous elements. Numerous details are set forth to provide an understanding of the examples described herein. The examples may be practiced without these details. In other instances, well-known methods, procedures, and components are not described in detail to avoid obscuring the examples described. The description is not to be considered as limited to the scope of the examples described herein.

FIG. 1 shows a portion of an example electrical power supply structure 10 installed between two floors F1, F2 of a building. FIG. 2 shows the structure 10 of FIG. 1 in isolation, and FIG. 2A is a partially exploded view of the structure 10. Structure 10 comprises a vertical bus section 100 extending through a hole in each floor. Each vertical bus section 100 comprises a lower portion 101A extending below the floor, an upper portion 101B extending upward from the floor, and a barrier support plate 150 between the lower and upper portions 101A and 101B. A spacer block 200 may be provided at each floor and placed between the barrier support plate 150 and the floor to hold the barrier support plate 150 at a predetermined distance above the floor, as discussed further below with reference to FIG. 5. A tap box 300 is provided between adjacent vertical bus sections 100 to provide electrical connections between the conductors thereof, and allow cables or other conductors to connect thereto, as discussed further below with reference to FIGS. 6, 6A, 6B and 6C. In FIG. 2A, the lower one of the spacer blocks 200 is illustrated between the tap box 300 and the lower bus section 100, but it is to be understood that the spacer block 200 would be slid over the lower section of lower bus section 100 such that the barrier support plate 150 of the lower bus section 100 is atop of the spacer block 200.

FIG. 3 shows an example lower portion 101A of a vertical bus section 100 for a structure such as structure 10 of FIG. 1. The lower portion 101A comprises a support structure having pair of opposed side rails 102, a back panel 104 extending between the rails 102, and a front cover 106, which form an enclosure for a plurality of conductors 110. As seen in FIGS. 3A and 3B, the conductors are held in place within the lower portion 101A by a plurality of conductor support members 120 extending in a transverse direction between the side rails 102. The cable support members 120 are longitudinally spaced apart along the length of the lower portion 101A. The side rails 102 of each of the lower portion 101A and upper portion 101B of each bus section 100 may be connected to the barrier support plate 150 (not shown in FIGS. 3, 3A, 3B) by a flexible joint.

Referring to FIGS. 2B and 2C, in some embodiments the barrier support plate 150 has a central aperture 151 with a pair of lower and upper mounting brackets 152A and 152B on each lateral side of the central aperture 151. The side rails 102 of each of the lower portion 101A and upper portion 101B of each bus section 100 are bolted to the lower and upper mounting brackets 152A and 152B, to provide a degree of flexibility in the connection between side rails 102 and support plate 150.

The upper portion 101B of each bus section 100 is substantially similar to the lower portion 101A. In some embodiments the lower and upper portions 101A and 101B have the same length. In some embodiments the lower and upper portions 101A and 101B have different lengths. In some embodiments the lower and upper portions 101A and 101B are sized so that each tap box 300 is at a predetermined height above each floor. The conductors 110 extend through the length of each bus section 100, and terminate in attachment tabs 112 that are connected to bus bars 310 in the tap boxes 300 as described below.

The conductors 110 are each insulated in some embodiments. The conductors 110 may comprise flexible cables in some embodiments. The conductors 110 may comprise rigid conductors such as pipes or the like in some embodiments. Utilizing pipes for the conductors 110 can advantageously allow a bus section 110 to have a smaller number of conductors 110 for carrying the same current, and fewer support members 120, in comparison to flexible cables, which may result in reduced cost. In embodiments using rigid conductors 110 such as pipes, flexible members such as for example metal braids are provided between conductors and bus bars 310 to accommodate expansion and contraction of conductors 110.

The conductors 110 are preferably continuous throughout the whole length of a bus section 100, and extend between the lower and upper portions 101A and 101B through one or more apertures in the barrier support plate 150. A sealing system is preferably provided around the apertures through the barrier support plate 150 to provide a water tight seal around the conductors 110. FIG. 2D shows a support plate 150 with an example sealing system 155. The sealing system 155 comprises a sealing barrier 156 across the central aperture 151. The sealing barrier 156 has a plurality of holes therethough with a sealing sleeve 157 around each hole. In the FIG. 2D example, only one phase of conductors 110 is shown inserted through the holes and held within the sealing sleeves 157. The FIG. 2D example also includes smaller holes and associated sleeves 159 for receiving grounding cables (only one of which is shown). Each of the conductors **110** terminate in an attachment tab **112** at the lower end of the lower portion **101**A, and another attachment tab **112** at the upper end of the upper portion **101**B. In the illustrated embodiment, the conductors **110** have generally circular cross section.

In the example illustrated in FIGS. **3**, **3**A, **3**B, the conductors **110** are configured to deliver three phase grounded electrical power, and are grouped by phase. The conductors of each group of first phase conductors **110**A, second phase conductors **110**B, third phase conductors **110**C and neutral conductors **110**N are arranged in a generally circular arrangement, as best seen in FIG. **3**B. Such a circular arrangement facilitates connection of the attachment tabs **112** to the tap boxes **300**, as described below. Also such a circular arrangement provides improved force cancellation between the three electrical phase groups of conductors **110** and the neutral group as opposed to other shapes.

In some embodiments, the bus sections **100** may comprise shielding. FIGS. **4**, **4**A and **4**B show an example lower portion **101**A' of a vertical bus section **100** that includes shielding. The example of FIGS. **4**, **4**A and **4**B is otherwise the same as the example of FIGS. **3**, **3**A and **3**B. In the illustrated example, a shield plate **115** is provided between the first phase conductors **110**A and the second phase conductors **110**B, and another shield plate **115** is provided between the second phase conductors **110**B and the third phase conductors **110**C. The shield plates **115** extend continuously throughout the lower portion **101**A', through slots in the cable support members **120**. As best seen in FIG. **4**B, the shield plates **115** do not extend the full depth between the back panel **104** and cover **106**. The shield plates **115** may be constructed from steel or aluminum in some embodiments. The thickness of the shield plates **115** may be selected based on forces and eddy currents on each electrical phase group and neutral group of conductors **110**. In some embodiments, shield plates **115** have a thickness of about 0.040" (0.1 cm).

FIG. **5** shows an example spacer block **200** for a structure such as structure **10** of FIG. **1**. The spacer block **200** comprises a flange **202** and a riser **204** with an aperture **206** therethrough. The aperture **206** is sized and shaped such that the lower portion **101**A of a bus section **100** is snugly received therein. In some embodiments, the spacer block **200** is constructed from steel or stainless steel. In some embodiments, the spacer block **200** may have fire retarding materials therewithin.

FIG. **6** shows an example tap box **300** for a structure such as structure **10** of FIG. **1**. The tap box **300** comprises a base **302** and a cover **304**. An opening between the base **302** and the cover **304** is provided on each of the top and the bottom for receiving the end of a bus section **100**. As seen in FIGS. **6**A, **6**B and **6**C, support brackets **306** extend from the base **302**, and bus bars **310** are attached to the support brackets **306** through insulating connectors **308**. The bus bars **310** have holes at either end to facilitate connection of the attachment tabs **112** of the conductors **110** thereto. FIG. **6**D shows a single conductor connected to each end of the bus bar **310** by means of an attachment tab **112**. The bus bars **310** may also each have a plurality of holes therethrough to facilitate connection of cables for power distribution from the tap box **300**. In some embodiment, the tap box **300** has partially cut holes or “knockouts” around the periphery of the base **302**.

FIGS. **7** and **7**A show a tap box **300'** according to another embodiment. Tap box **300'** has a plurality of infrared (IR) windows **303** in its cover **304**. IR windows **303** facilitate inspection of the internal connections of the tap box **300'** without removing cover **304** by allowing thermal imaging of the connections to the bus bars **310**.

The present disclosure may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive.

The invention claimed is:

1. An electrical power supply structure comprising:

a barrier support plate comprising one or more openings, the barrier support plate configured for mounting over a hole through a floor of a building;

a first support structure extending longitudinally upward from an upper side of the barrier support plate; and,

a second support structure extending longitudinally downward from a lower side of the barrier support plate through the hole,

wherein each of the first and second support structures comprises a longitudinally extending enclosure having a plurality of transversely extending conductor support members, and whereby the structure is configured to receive a plurality of conductors extending longitudinally therethough, with the conductors extending through the one or more openings in the barrier support plate and being supported by the plurality of transversely extending conductor support members of the first and second support structures.

2. The electrical power supply structure of claim **1** comprising a spacer block having an opening sized to fit an outer dimension of one of the first and second support structures and configured to be mounted between the barrier support plate and a floor of a building such that the barrier support plate is held at a predetermined height above the floor.

3. The electrical power supply structure of claim **1** wherein the transversely extending conductor support members are configured to support conductors in a plurality of phase groups.

4. The electrical power supply structure of claim **3** wherein the transversely extending conductor support members are configured to support conductors arranged in a circular arrangement.

5. The electrical power supply structure of claim **3** comprising a shield plate positioned between phase groups.

6. The electrical power supply structure of claim **1** wherein the transversely extending conductor support members are configured to support conductors in the form of pipes.

* * * * *